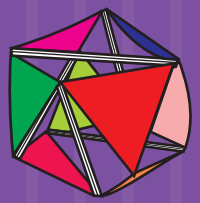
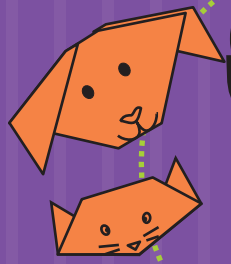
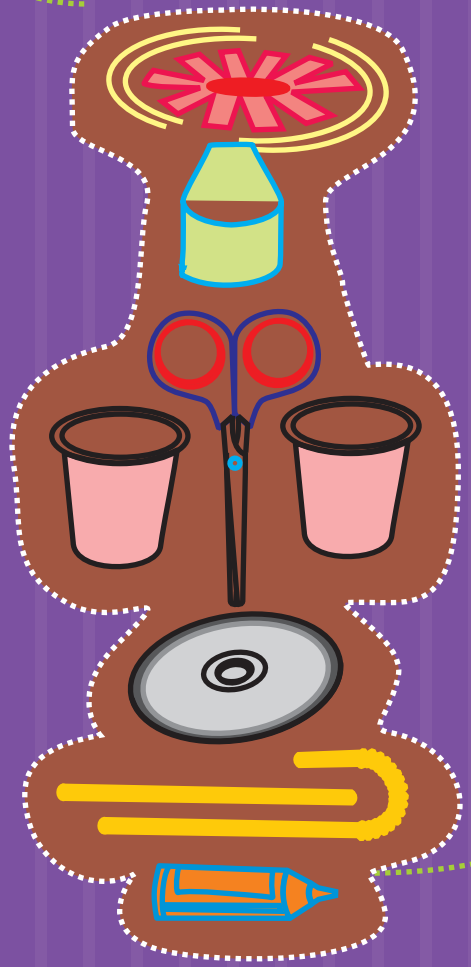
There are amazing possibilities of doing creative science experiments using simple, readily available stuff. This book, contains many such activities - how to make a Helicopter Fan using a motor and fan; how to understand pressure using throw away plastic bottles and to make simple electric Motors and understand their function. These activities apart from being fun will also help school children in understanding various science concepts in much greater depth.





SCIENCE SPARKS

ASHOK RUPNER



Illustrations - Reshma Barve

ASHOK RUPNER has a post graduate degree in Physics from the Savitribai Phule Pune University. He also holds a B.Ed. For the last 20 years he has been deeply involved in science popularization. For 8 years he worked with the Mobile Science Lab of Vidyan Vahini. Over the years he has conducted over 3000 hands-on science workshops in various schools and colleges. For four years in a row he won the Most Distinguished Science Activities Award at Scifest Africa, in Grahamstown, South Africa. Since 2004 he has worked at the Children's Science Center of IUCAA. He has designed hundreds of science teaching aids and models which have been uploaded on the website www.arvindguptatoys.com The Science Popularization team at IUCAA have made 1070, short videos on low-cost models, science activities and toys. These videos have been dubbed in many languages. Currently the website has 8250 short videos on Youtube which have been viewed by over 55-million people across the world.

RESHMA BARVE studied Commercial Arts at the Abhinav Kala Mahavidyalaya, Pune. She is a freelance artist and designer and has illustrated many children's books.

Dedicated to Dr. Madhukar Deshpande, Mrs. Pushpa Deshpande and Mr. Jayant Phalke of Vidnyanvahini for generously sharing their vision and knowledge.

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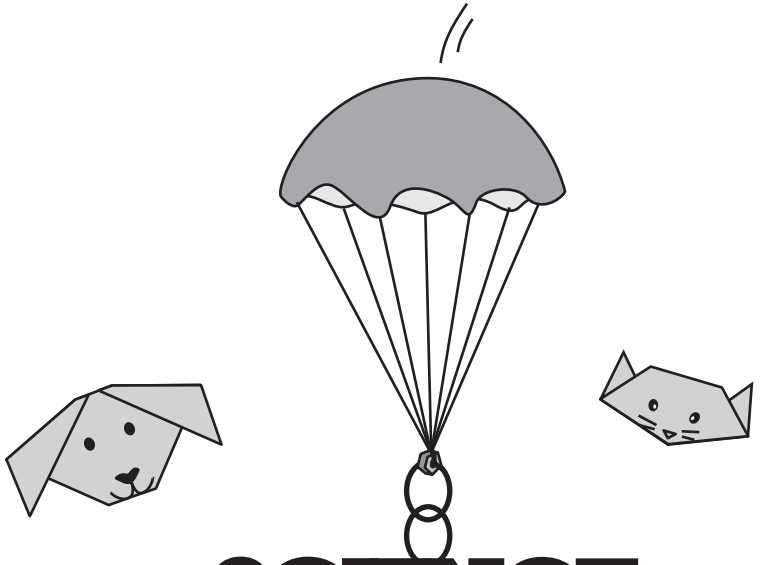
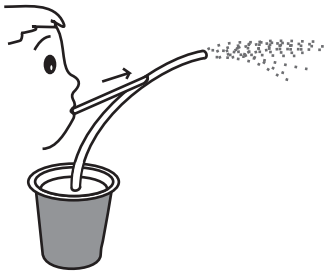
First Edition : April 2017

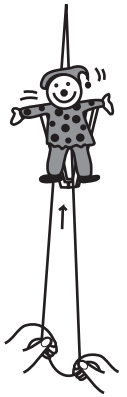


SCIENCE SPARKS

ASHOK RUPNER

Illustrations: Reshma Barve





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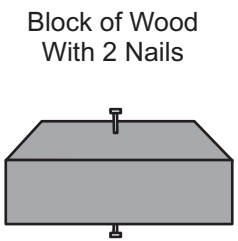
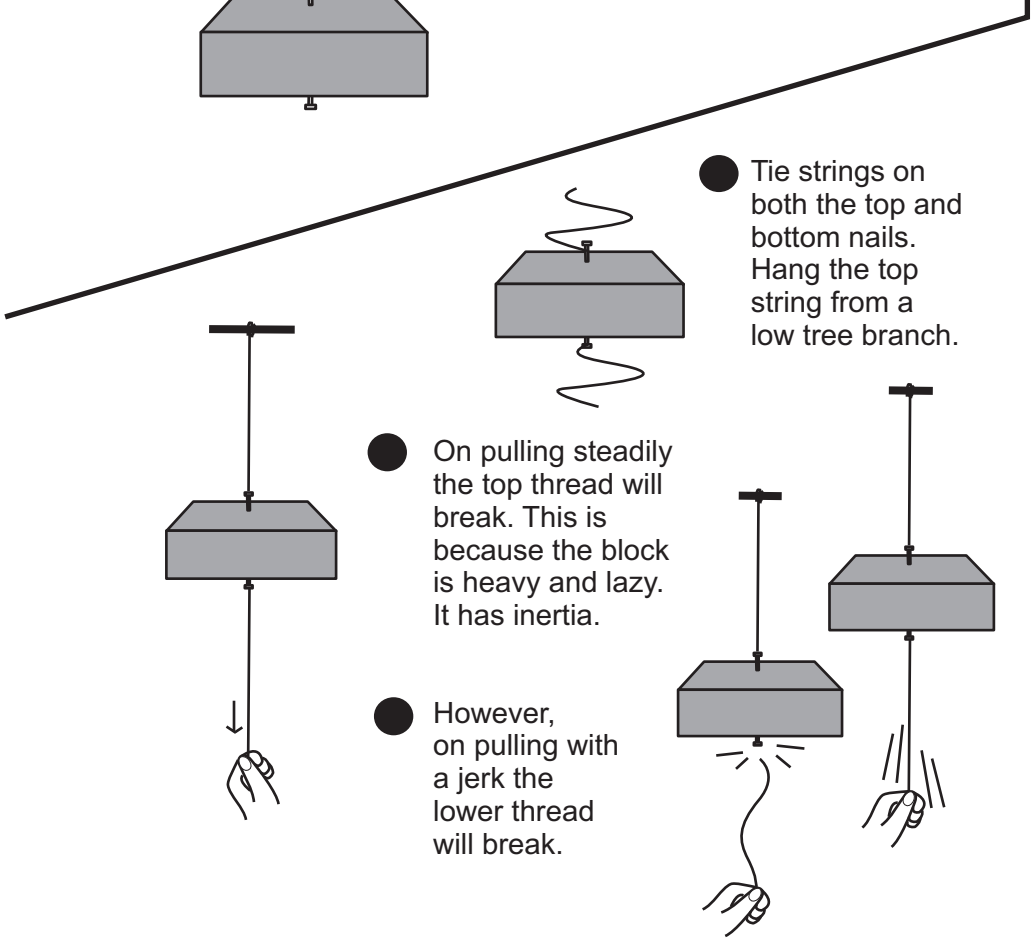
FUN WITH INERTIA





- Tie strings on both the top and bottom nails. Hang the top string from a low tree branch.
- On pulling steadily the top thread will break. This is because the block is heavy and lazy. It has inertia.
- However, on pulling with a jerk the lower thread will break.

A steady pull enables the force to be transmitted to the top. As the upper thread also supports the weight of the block, so it breaks.

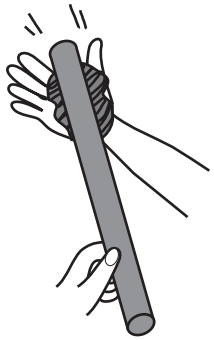
STATIC WAND

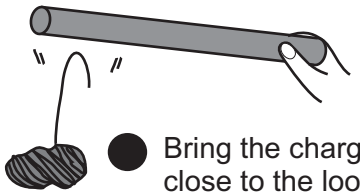
PVC Pipe

Wool

Aluminium Can

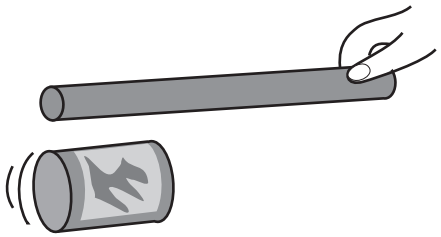
- Rub a PVC pipe with wool. The pipe will acquire an electrical charge.





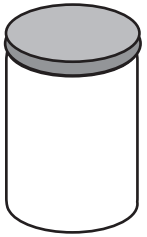
- Bring the charged pipe close to the loose end of a ball of wool. The wool end will be attracted to the pipe and stand-up.

- Place an aluminium can on the floor. Bring the charged pipe close to the can. The can will repel and will try to roll.

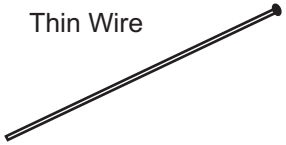


Rubbing the PVC pipe with wool knocks off some its electrons.The charged pipe can now attract paper, wool and make an aluminium can roll.

BLOW OUT A CANDLE



Plastic Jar



Thin Wire

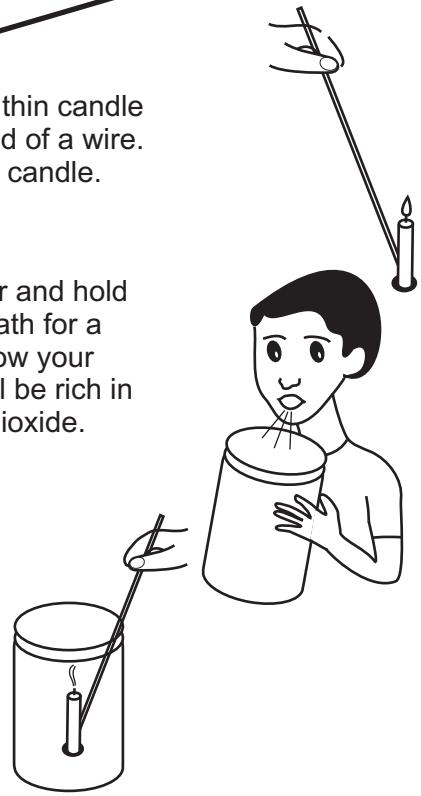
Matchbox

Thin Candle

- Attach a thin candle at the end of a wire. Light the candle.

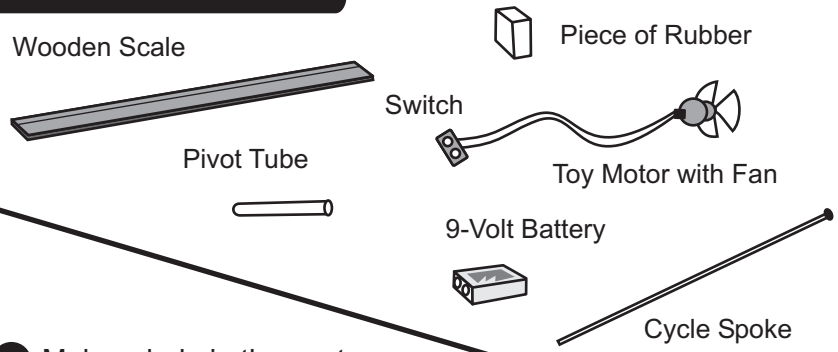
- Inhale air and hold your breath for a while. Now your lungs will be rich in carbon dioxide.

- Slowly, exhale air into the jar. Lower the lighted candle in jar as shown. After a while the candle will extinguish.

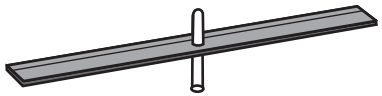


This experiment shows that we exhale out more carbon dioxide which is heavier than air and can extinguish a candle.

HELICOPTER FAN

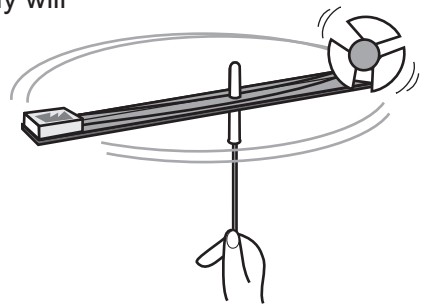


- Make a hole in the centre of the scale. Press fit the pivot tube in the middle.



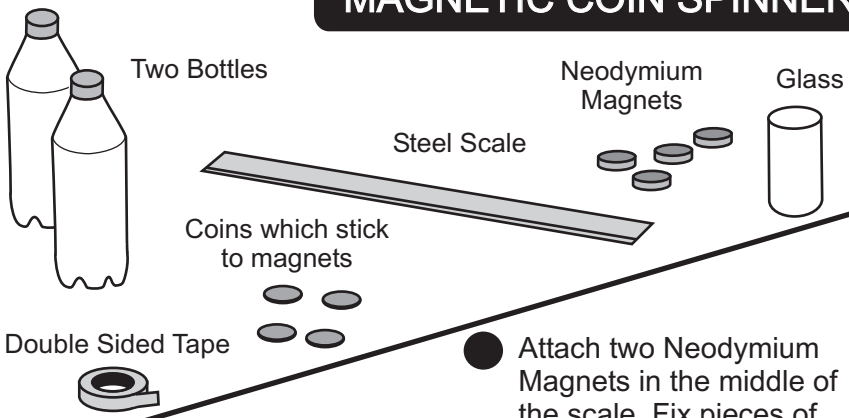
- Glue the toy motor to a piece of rubber. Fix the motor-fan on one end and the battery on the other end of the scale.

- Place a cycle spoke to make the model balance on its pivot. On switching the motor "ON" the whole assembly will keep rotating in circles.

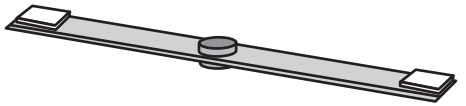


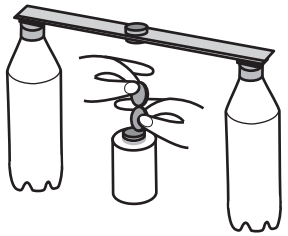
As the spinning motor throws air forward it is pushed back because of action-reaction. This makes the whole assembly spin.

MAGNETIC COIN SPINNER

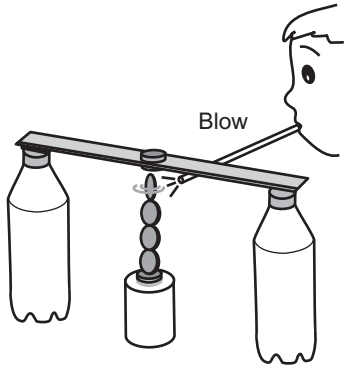


- Attach two Neodymium Magnets in the middle of the scale. Fix pieces of double tape on the ends.





- Fix the scale on the bottle lids with tape. Attach 2 Neodymium magnets on the glass base - one from inside, other from outside. Stand a few coins on the magnets as shown. The top coin should be close to the scale magnet.



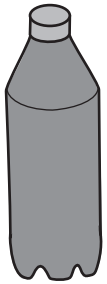
- Blow with a straw on the side edge of the top coin. It will spin at a very fast speed.

The top coin touches only a little part of the lower coin. It is attracted to the magnet above it. Because of very low friction the air stream spins the coin very fast.

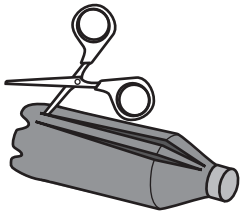
TWISTED BOTTLE VASE

Scissors

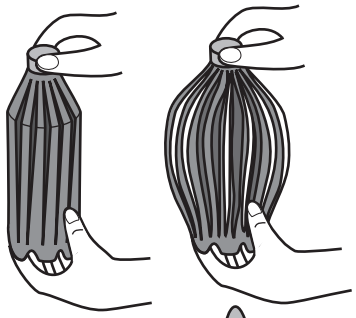
Stiff Plastic Bottle



- With a scissors make 1-cm wide cuts along the whole length of the bottle.



- Hold the bottle with both hands and press. The bottle will expand and bloat.

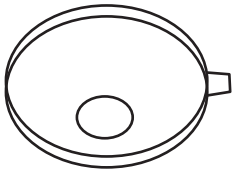


- Then hold the bottle and twist the top and base in opposite directions. The bottle will retain its elegant shape even after twisting. Place flowers in this vase.

Reduce! Recycle!! Reuse!!! You can also make a very beautiful lamp shade from the slit bottle.

LIFTING WITHOUT TOUCHING

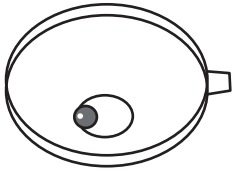
Plastic Funnel without the tube

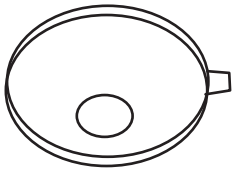


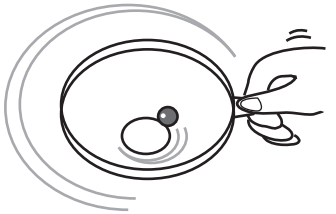
Marble

- Cut the tube end of a medium size plastic funnel.

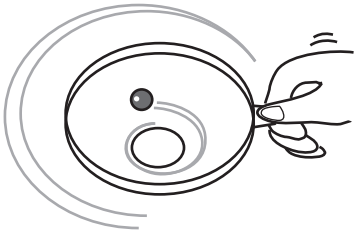
- Place the marble in the funnel hole. Hold the funnel and start rotating it.

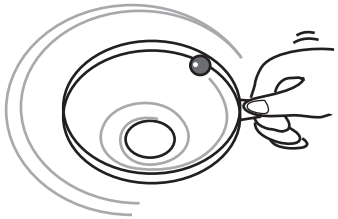






- The marble will start rotating round-and-round in the funnel and slowly rise up.

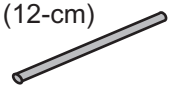




As you rotate the funnel Centrifugal Force acts on the marble and gradually makes it rise.

MAGNETIC ROTATION - EULER'S DISC

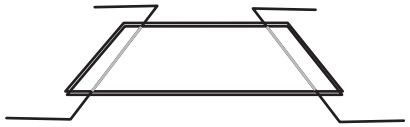
Neodymium Magnets



Steel Rod (12-cm)

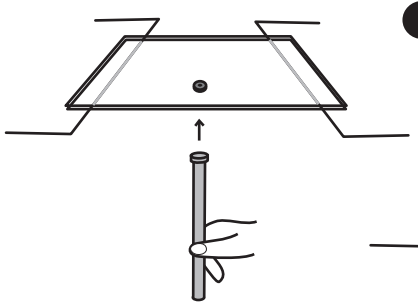
Glass Sheet

- Rest the edges of the glass sheet between two tables.

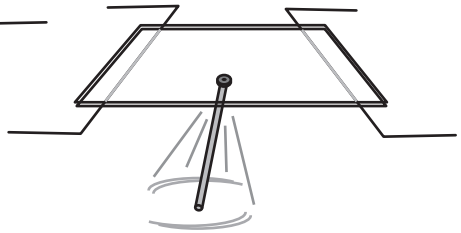


- Attach a Neodymium magnet to one end of the steel rod.

- Place another Neodymium magnet on the top of the glass. Stick the magnet and rod from below.



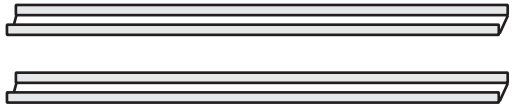
- Give the rod a twirl and it will keep spinning for a very-very long time.

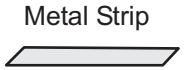


A spinning disc on a flat surface is called an Euler's Disc - named after the Swiss mathematician Leonard Euler. The secret of this unusual motion is the very low energy loss due to friction.

MAGNETIC RAIL

Aluminium Channels (50-cm long)



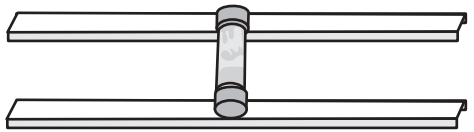


Metal Strip

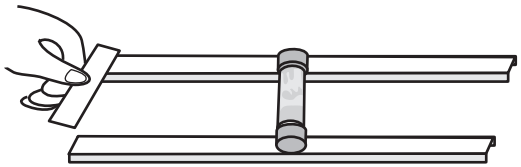
Cylindrical Neodymium Magnets

1.5-Volts Rechargeable AAA Battery

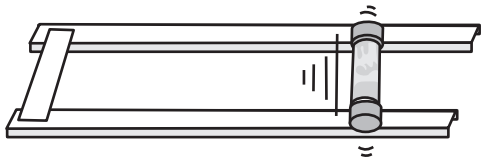
- Stick both magnets to the ends of the battery. Place the magnets like wheels on the aluminium rails.



- Join the two rails with a metal strip on the left hand side. This will complete the circuit.

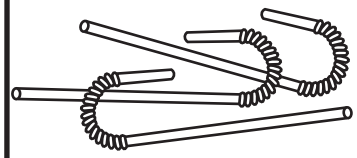


- Once the circuit is complete the battery along with the magnets will roll on the aluminium channels.



When current flows in the circuit the magnetic field of the magnet will be perpendicular to the aluminium channels. Then a force will move the battery along with the magnets. The direction of movement will depend on direction of the magnetic field.

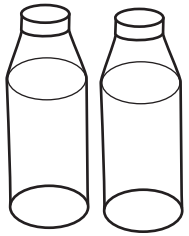
TWO BOTTLE FOUNTAIN



Flexible Straws

Plastic Cup

Scissors

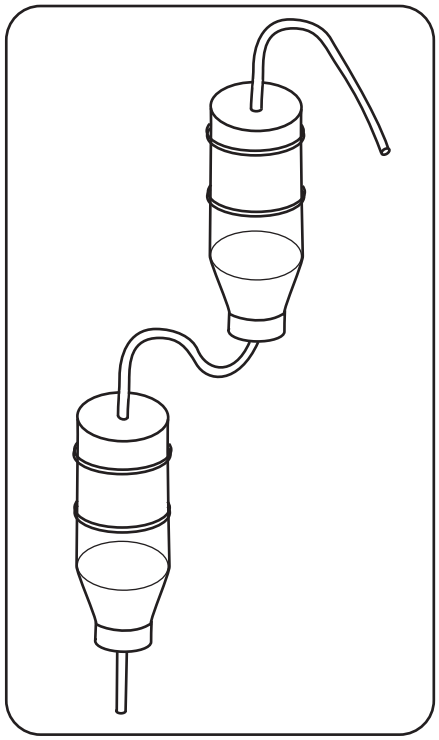


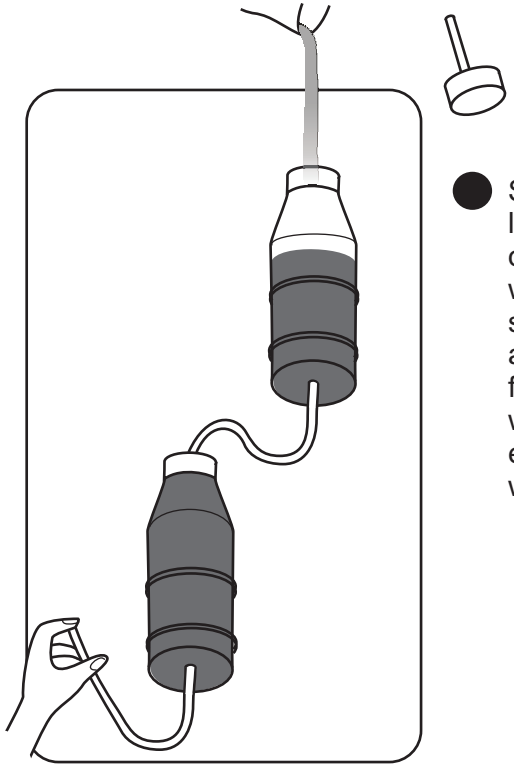
Plastic Bottles

Rubber Glue

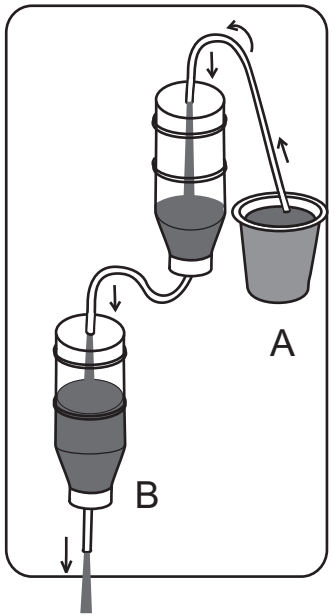
- Make small holes in the lids and bases of two similar plastic bottles.

- Connect the two bottles with one flexible straw. Fix a flexible straw on the base of the top bottle and the lid of the lower bottle. Seal all joints with rubber glue. Mount both the bottles on a thick vertical board.





- Shut the open end of the lower straw. Open the lid of the top bottle and fill it with colour water. Then screw the lid. Invert the assembly and dip the flexible straw in a cup of water. On opening the end of the lower straw water will start flowing.

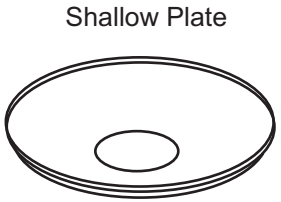


- In this two bottle siphon water actually flows from higher level A to lower level B.

As water flows from the lid of bottle B a partial vacuum is created at the top. This sucks water from top bottle. The vacuum thus created sucks water from the cup A. This is how two bottle siphon works.

OPENING-UP

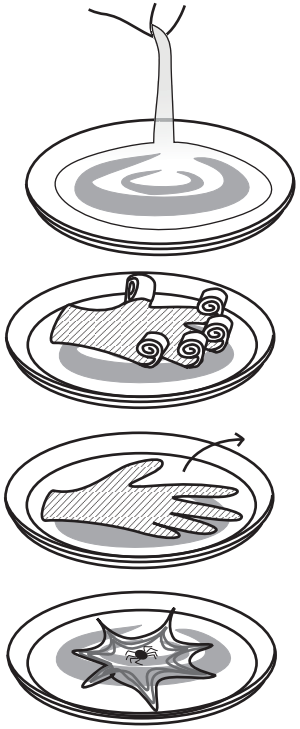
Newspaper Hand and Flower cutouts



Shallow Plate

Cup of Water

- Pour some water in a shallow plate.



- Cut a hand profile, or a pointed flower from an old newspaper. Curl all the fingers or petals as shown.

- Now place the curled cutout in water.
- After a while all the curled fingers will straighten out.

As the newspaper fibres get wet they stretch and elongate and so the fingers of the hand straighten out.

PLASTIC TUBE SPRAY

Plastic Tube (15-cm)

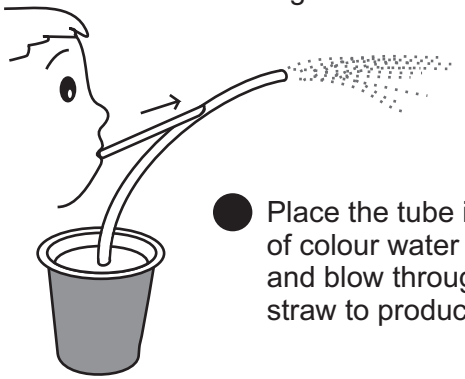
Scissors

Colour Water

Stiff Straw

- Make a small hole about one-third from one end in the plastic tube.

- Press fit a stiff straw at an angle in this hole.



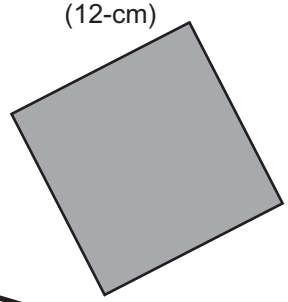
- Place the tube in a cup of colour water as shown and blow through the stiff straw to produce a fine spray.

As you blow through the straw the high speed of air produces a low pressure which sucks-up water from the cup. These water particles emerge from the tube as a fine spray.

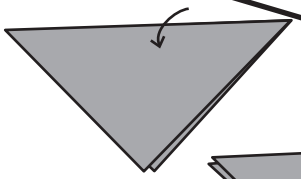
ORIGAMI CAT

Sketch Pen

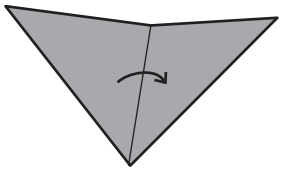
Paper Square
(12-cm)



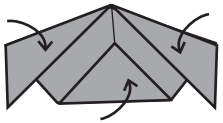
- Fold the square along the diagonal to make a big triangle.



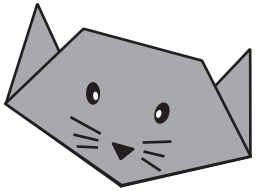
- Fold the big triangle in half to make a smaller triangle.



- Open the small triangle to show the middle crease.



- Fold down left and right hand corners to make two ears. Fold the base point upwards into a small triangle.

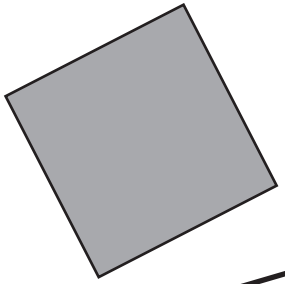


- Upturn the model. Draw eyes, mouth and whiskers to make a Paper Cat.

Children will love making this simple Paper Cat.

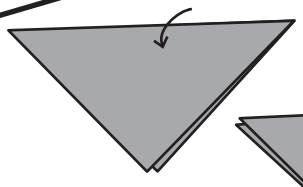
ORIGAMI DOG

Paper Square
(12-cm)

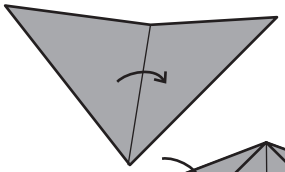


Sketch Pen

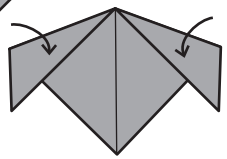
- Fold the square along the diagonal to make a big triangle.



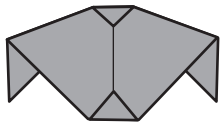
- Fold the big triangle in half to make a smaller triangle.



- Open the small triangle to show the middle crease.



- Fold down left and right hand corners to make two ears.

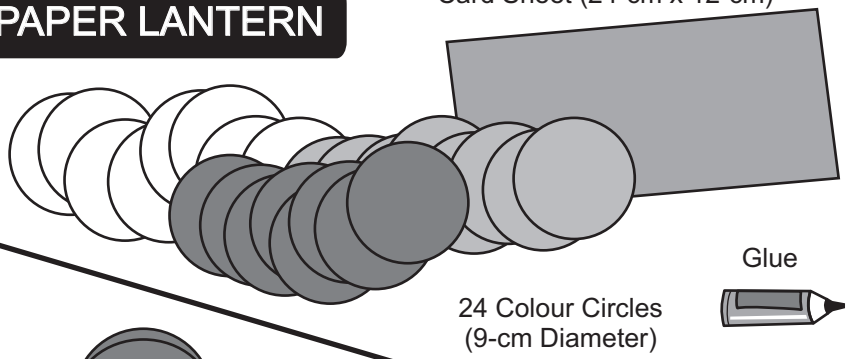


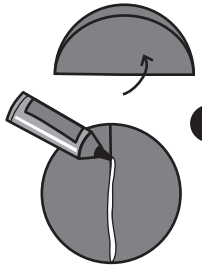
- Upturn, and fold two small triangles on the top and bottom.

- Upturn the model. Draw eyes, nose and mouth to make a Paper Dog.

Children will love making this simple Paper Dog.

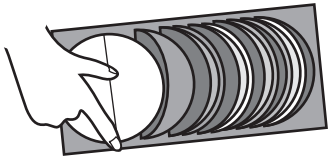
PAPER LANTERN



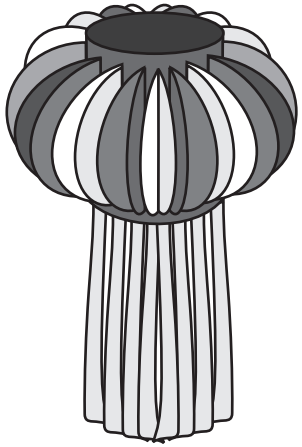


- Fold colour circles in half. Apply glue along their diameter.

- Stick the glued line of the circles on a rectangular card sheet. Stick 24 circles next to one another.

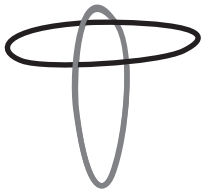


- Then tape the two ends of the rectangular card strip to make a circular hoop. Hang tassels to decorate the Paper Lantern.

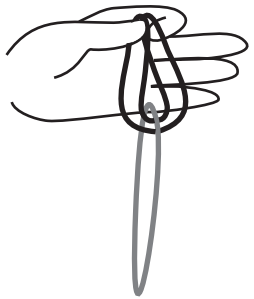


Hang a small electric bulb in this elegant lantern to celebrate Diwali or Christmas.

STRING TRICK



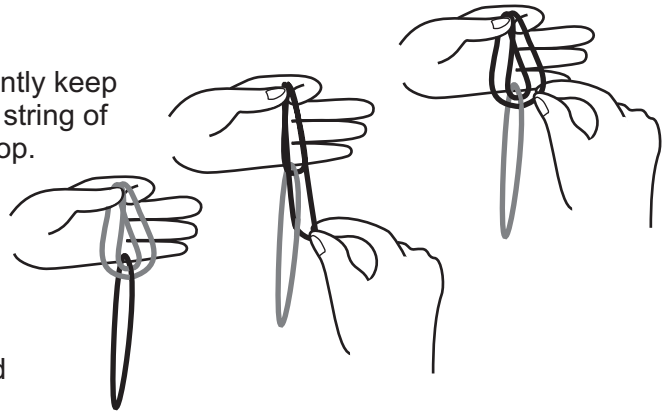
- Keep the dark loop horizontal. Slip the light loop on top.



- Bring the two ends of the dark loop together and hold them with your left thumb and index finger.

The challenge is to interchange the positions of the Dark and Light loops.

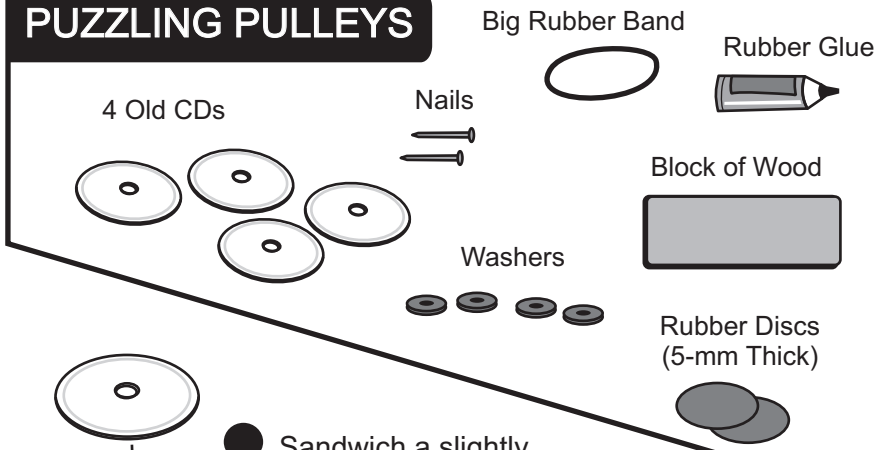
- For this, gently keep pulling one string of the Dark loop.

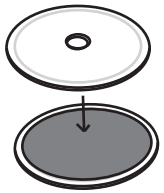


- Soon the Light loop will be on the top and the Dark loop will be below.

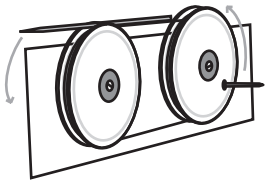
This interesting trick will amuse your friends no end. This trick can also be performed using two long rubber bands.

PUZZLING PULLEYS

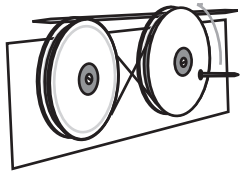




- Sandwich a slightly smaller rubber disc between two old CDs to make a pulley.



- Stick steel washers in the centre on both sides of the two pulleys.

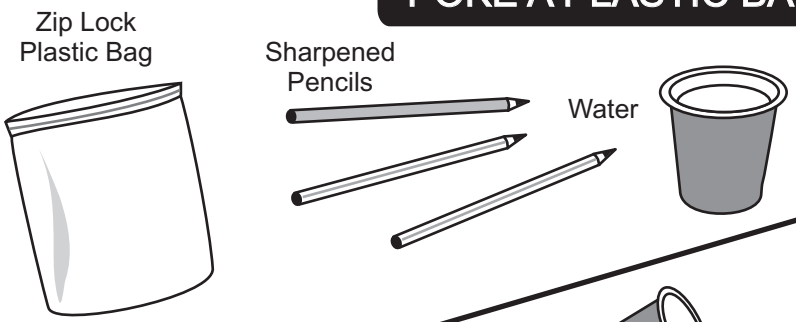


- Mount both pulleys on a wooden block. Attach a handle to one pulley. Stretch a big rubber band as shown to connect the two pulleys. Place a wooden stick in the groove of both pulleys. On rotating, both pulleys will rotate in the same direction and the stick will fall.

- Now place the rubber band in a figure of 8 formation. Now both the pulleys will rotate in opposite directions. This time the wooden stick will move to-and-fro from left-to-right, but will not fall down.

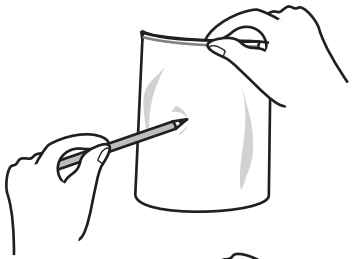
This is a very intriguing experiment. When the rubber band is crossed both pulleys rotate in opposite directions resulting in the stick moving to-and-fro without falling.

POKE A PLASTIC BAG

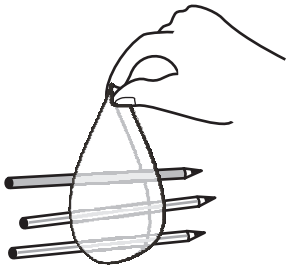


- Fill water in a zip lock plastic bag. Remove all the air and then lock the bag.

- Take a sharpened, pointed pencil and poke it right through the plastic water bag. Not a single drop of water will fall.

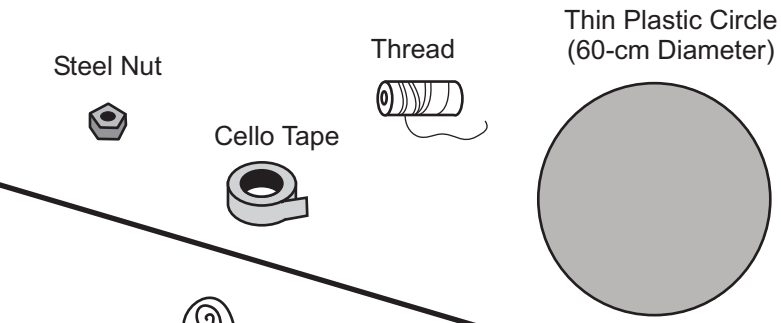


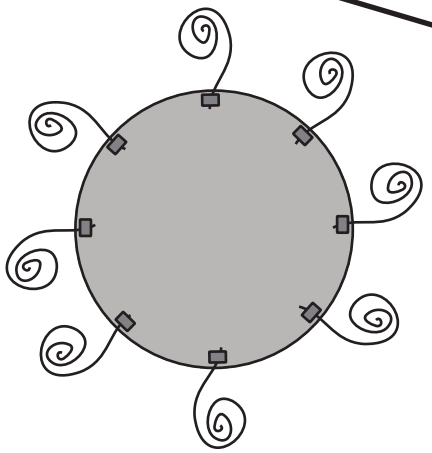
- You can poke several pencils right through the plastic water bag.



Why doesn't any water spill?
The reason is that as the pencil pierces, the plastic contracts and seals the hole!

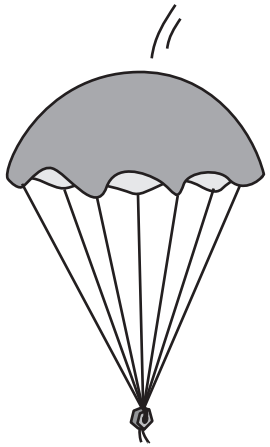
POLYTHENE PARACHUTE





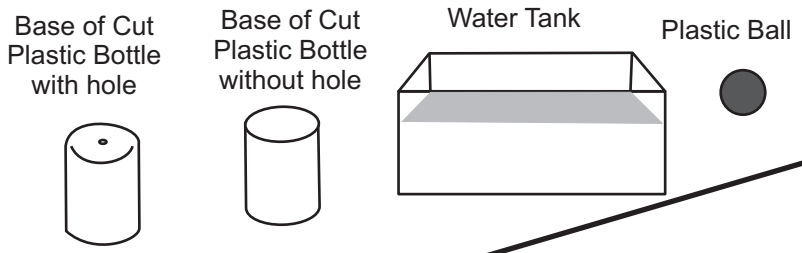
- Tape 30-cm long pieces of thread at 8 equidistant points on the rim of the plastic circle.

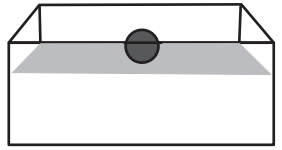
- Tie free ends of all the threads to a cycle steel nut. Then throw the parachute from the second floor. It will gently sail down.



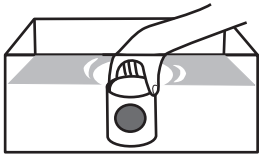
The light weight of the parachute and its large area offers a lot of resistance while falling in the air. Therefore the parachute descends very gradually and gracefully.

FLOATING AND SINKING

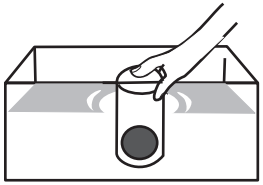




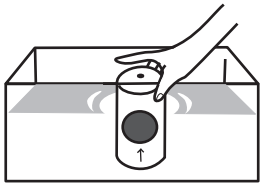
- Place a small plastic ball in a water tank. The ball will float.



- How to push the ball to the bottom of the water tank without physcially touching it? Place a cut bottle on the ball. Push the bottle down in water and the ball will sink.



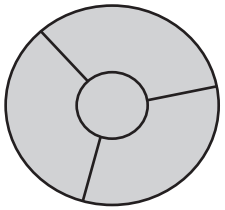
- Repeat the experiment with a cut bottle with a hole in the base. On shutting the hole with your finger and pushing the bottle down, the ball will also sink.

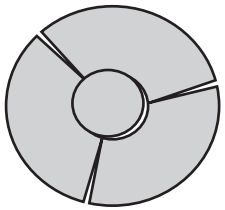


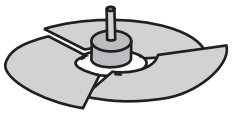
- However, once you lift your finger and open the hole, water will enter the bottle and the ball will gradually float and rise in the water inside the bottle.

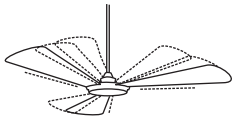
This is a simple experiment to explore sinking and flotation.

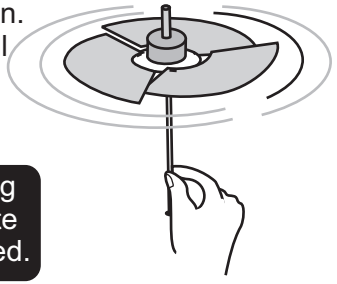
PLATE SPINNER











- Cut three equal segments from a Styrofoam Plate leaving a circle in the centre.
- Staple the three segments on the circle to make a fan.
- Press fit a 2-cm piece of stiff straw in a bottle lid.
- Stick the bottle lid in the centre and on top of the fan as shown.
- Press fit a 1-cm stiff straw piece at right angles in a cycle spoke.
- Perch the fan on the cycle spoke and place the model below a ceiling fan. The Plate Fan will spin very fast.

When the breeze from the ceiling fan strikes the blades of the Plate fan it makes it spin at a high speed.

Bottle Lid

Stapler

Styrofoam Plate (25-cm Diameter)

Cycle Spoke

Stiff Straw

Cello Tape

Scissors

PEANUT INSECT

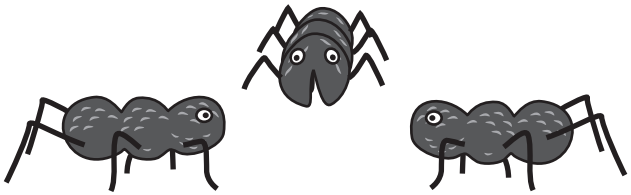
Groundnut

Thin Electrical Wire

Water Colours

Paint brush

- Paint groundnuts with bright colours to make them look pretty.
- Make small holes and weave three pieces of electrical wire in the groundnut. Shape the wires to make insect legs.
- Make the whole insect family!



There are lots of creative things that you can make from simple stuff lying in the house.

BALL SHOOTER

Balloon

Paper Ball

Cut neck of a Plastic Bottle

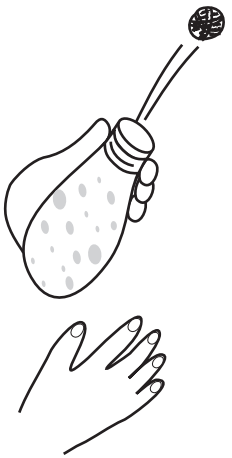
Small Rubber Bands

Scissors

- Cut near the neck of an old plastic bottle with a little bit of the slant surface. Ensure there are no sharp edges.

- Stretch a balloon on the bottle neck until the threads. Make a small paper ball. Stretch a few rubber bands on the ball. Place the ball in the balloon.

- Hold the bottle neck with the left hand. Hold the paper ball with the right hand then stretch the balloon and shoot.



- The paper ball will fly 20-metres away.

Caution: Never aim the ball at any living being.

The potential energy stored in the ball is converted into kinetic energy.

MAGNETIC SPINNER

Bottle Metal Cap

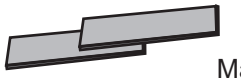
Cycle Spokes

Scissors

Spiral Pattern Card

Rubber Glue

Strips of Corrugated Board



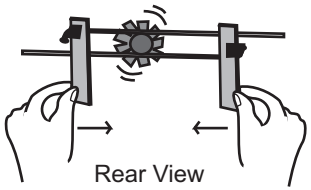
Magnet

Cello Tape

- Weave two cycle spokes on two strips of corrugated board.

- Tape the cycle spoke heads to the board. This will be the track. By moving the strips the length of the track. can be changed.

- Cut the rim of the metal lid to make a flower. Bend the petals outwards. Stick a magnet in the centre of the lid. Stick a Spiral Pattern on top.



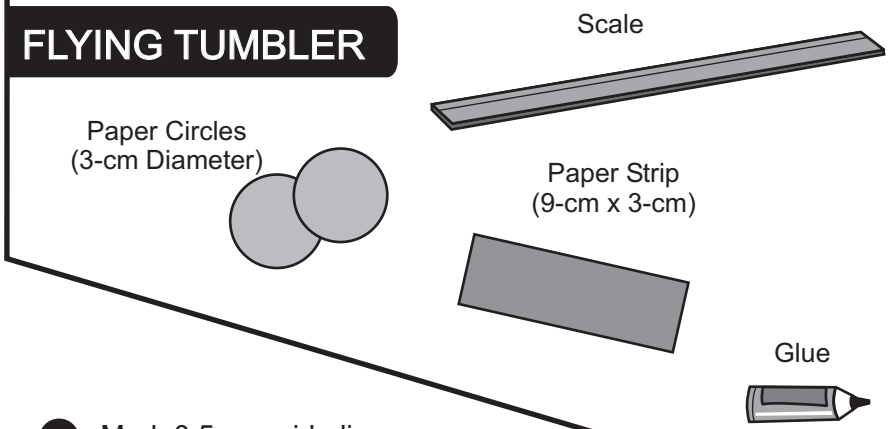
Rear View

Front View

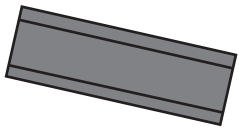
- Place the lid on the spoke track. Hold corrugated strips - pull them apart or push them in, to change the length of the track. This will make the lid spin on the track.

The lid sticks to the track because of the magnet. The lid spinner will rotate clockwise or anti-clockwise depending on whether the track length increases or decreases.

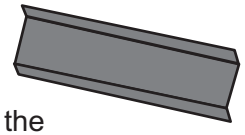
FLYING TUMBLER



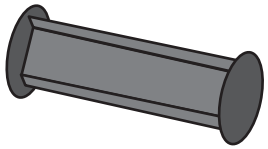
- Mark 0.5-cm wide lines along both long edges of the strip.



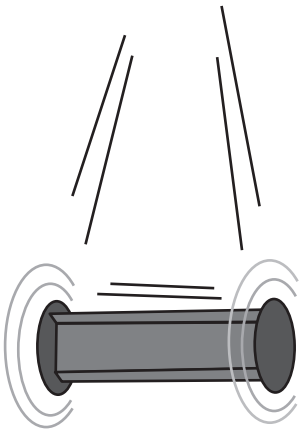
- With the help of a scale fold both edges in opposite directions.



- Apply glue on the short edges of the strip and stick both circles on its ends to make the Flying Tumbler.

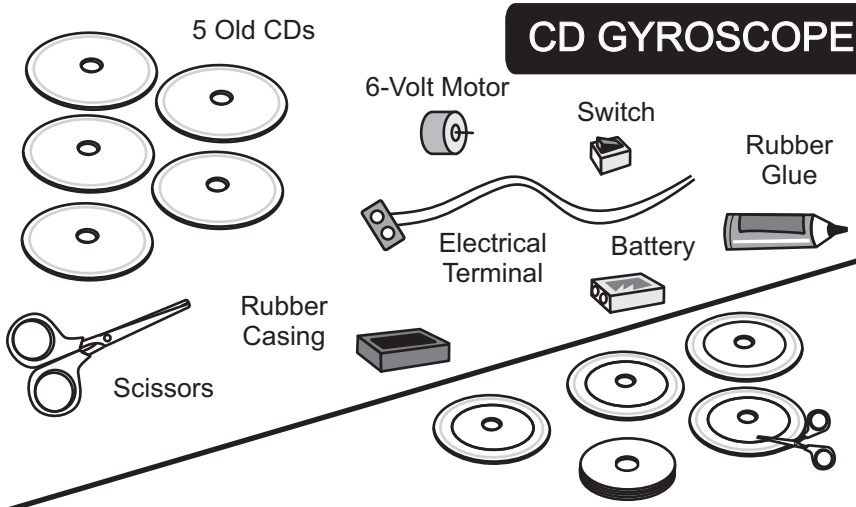


- On chucking the paper tumbler up in the air it will come tumbling down.



The shape of the tumbler is responsible for its spinning and slow descent in the air.

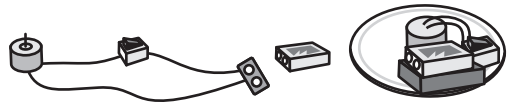
CD GYROSCOPE



- Cut and glue 4 old CDs to make a thick and heavy stack.

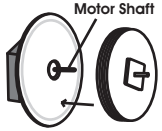
- Cut a 3-cm square piece of old CD and stick it in the centre of the stack. Make a hole and glue a refill in this hole.

- Connect a 6-Volt motor, On/Off Switch to the 9-Volt battery terminals.



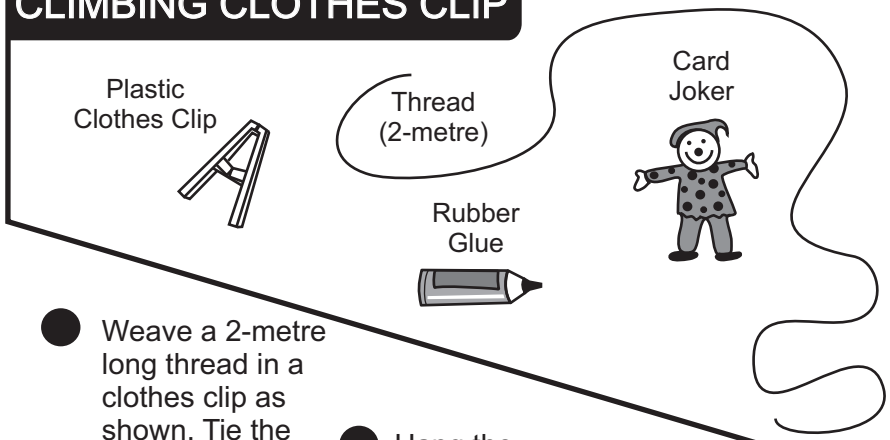
- Glue the motor to another old CD. Glue the rubber casing on the CD and fix the battery in it.

- Press fit the thick stack of CDs in the motor shaft. Switch "ON" the motor. The single CD will keep standing and will slowly rotate. It will not fall.

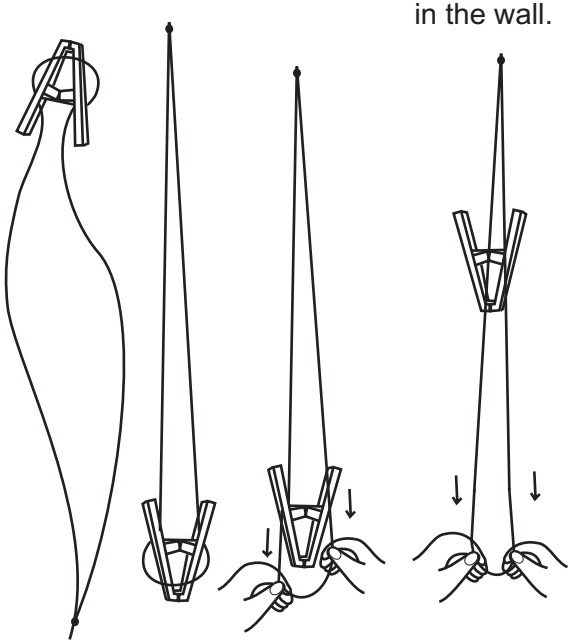


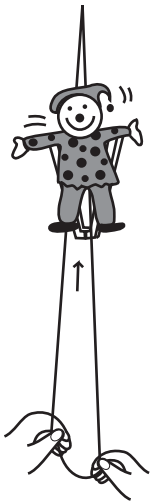
This is a simple Gyroscope. Even when tilted the CD will return to its original position because of Conservation of Angular Momentum.

CLIMBING CLOTHES CLIP



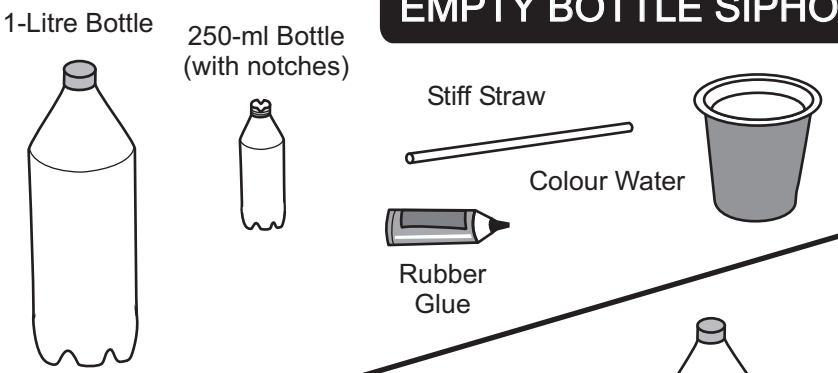
- Weave a 2-metre long thread in a clothes clip as shown. Tie the ends in a knot.
- Hang the middle of the thread from a nail in the wall.
- Hold the lower strings with both hands. Pull them alternately to make the clip climb up.
- Stick a card Joker on the clip. On pulling the threads the Joker will climb. On releasing them it will come down.



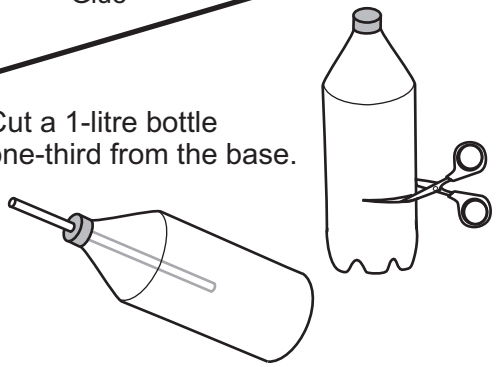


This delightfully simple toy is based on the principle of friction and gravity.

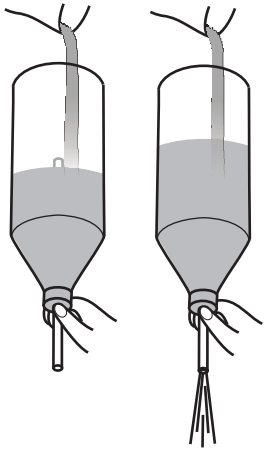
EMPTY BOTTLE SIPHON



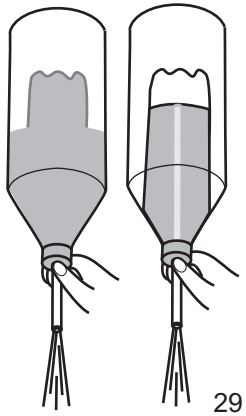
- Cut a 1-litre bottle one-third from the base.



- Make a small hole in its lid and press fit a stiff straw. Seal the joint with rubber glue.
- Hold the bottle vertically and pour coloured water. All the water above the straw level will drain out. How to drain the remaining water?
- For this, invert a small notched bottle on the straw. This will drain out most of the remaining water.



On inverting the small bottle with notches, water will climb in it and the Siphon will restart. Then most of the water from the big bottle will drain out.



LOOPS TO SQUARE

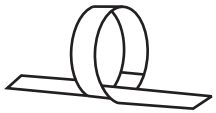
2 Strips of Paper
(20-cm x 3-cm)

Scissors

Glue

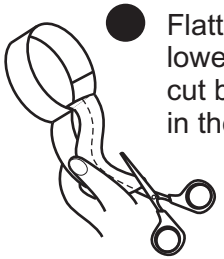
- Glue the ends of one strip to make a paper loop.

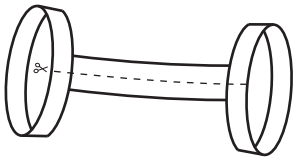
- Glue this loop in the middle of the other strip.



- Stick the ends of the second strip. Now you will see two loops at right angles to each other.

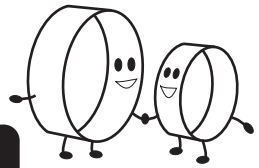
- Flatten the lower loop and cut both layers in the middle.





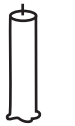
- On opening you will be surprised to see a Square!

- On opening the model will look like a handcuff. Again cut along the dotted line .

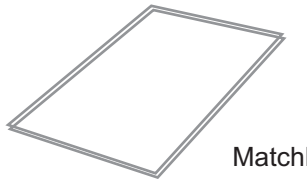


This is nice paper activity. Repeat this experiment with a small and big loop. What do you expect to get?

FLAME IN WATER



Candle



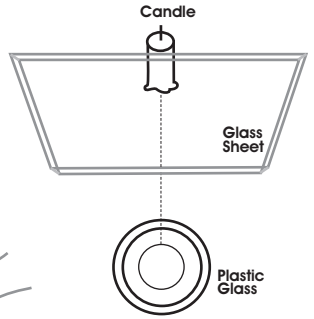
Sheet of Glass

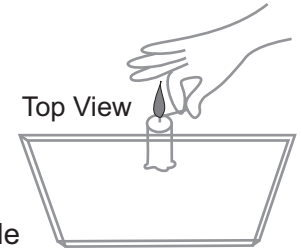
Plastic Glass

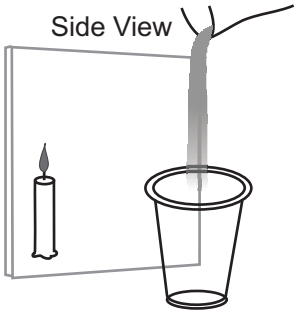
Matchbox

Water Jug

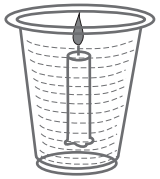
- Stand the glass sheet vertically. Place the candle and plastic glass as shown. They should be in line and equidistant from glass sheet.







- Light the candle and adjust the position of the glass such that the candle appears in the glass.



- On filling the glass with water the candle will appears burning inside the glass of water.

This illusion is because a virtual image of the burning candle is formed in the water glass.

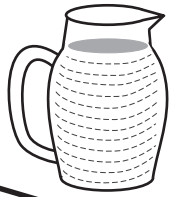
BALLOON BOTTLE PUMP

Balloon

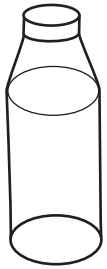
Flexible Straw

Scissors

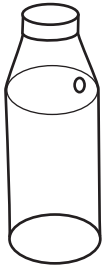
Water Jug



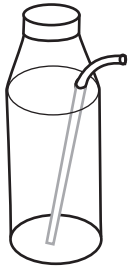
Plastic Bottle



- Make a small hole in a stiff plastic bottle near its neck.

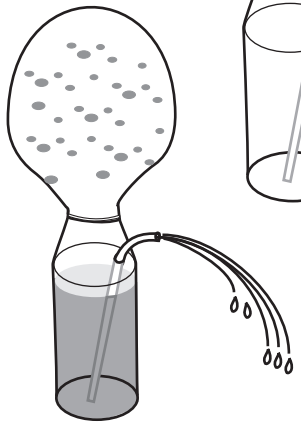


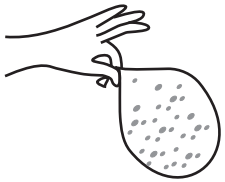
- Press fit a flexible straw in this hole. Seal the joint with rubber glue.



- Fill the bottle three-fourth with water.

- Stretch the mouth of an inflated balloon and place it on the mouth of the bottle. Now leave the balloon. Soon water will gush out from the flexible straw.

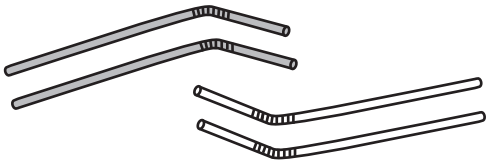




In this simple pump - pressurized air from the balloon will lift water up the straw like a pump.

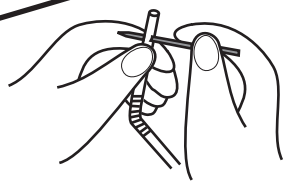
STRAW STRUGGLE

4 Flexible Straws

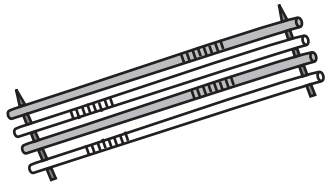


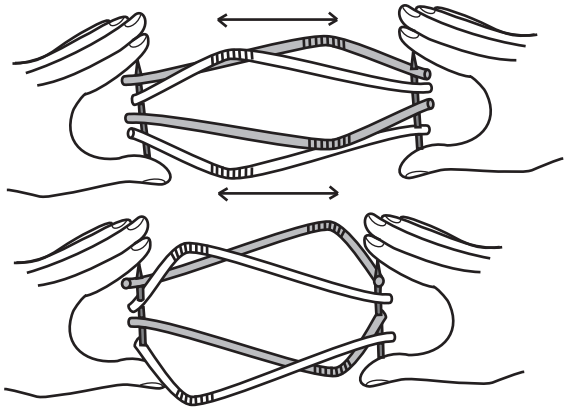
2 Toothpicks

- Make holes on both ends of all four straws.



- Weave all four straws in two toothpicks as shown.



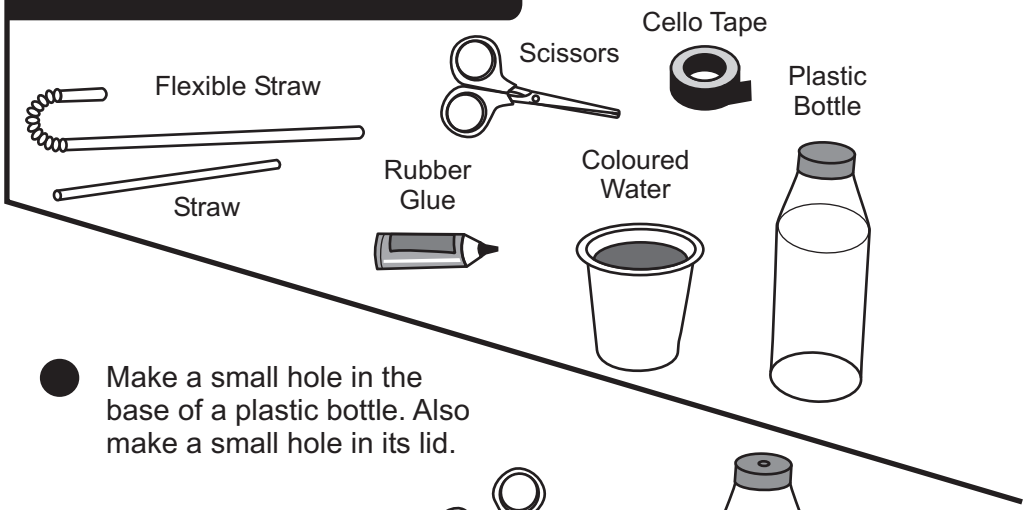


- Bend and phase out all the four straws at their crimped points.

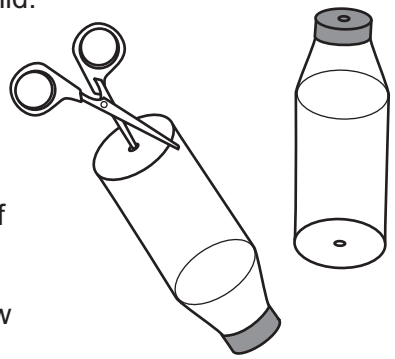
- On pushing-pulling the straws you will find a very dynamic pattern of movement at play.

This snapping action occurs because the flexible straws have crimpings which can bend and again regain their original form.

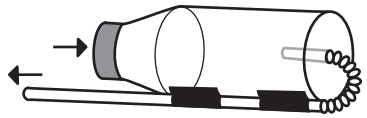
STRAW BOTTLE SIPHON



- Make a small hole in the base of a plastic bottle. Also make a small hole in its lid.

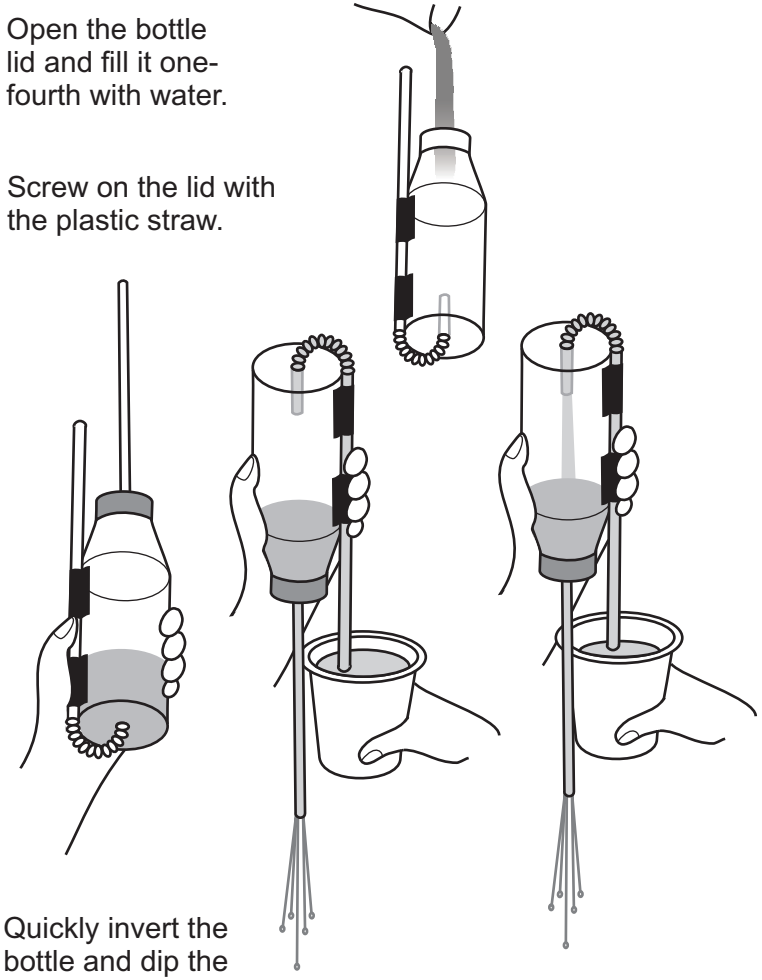


- Press fit the small end of the flexible straw in the base hole. Seal the joint with glue. Bend the straw and tape it to the bottle.



- Insert a stiff straw in the bottle lid. Seal the joint with rubber glue.

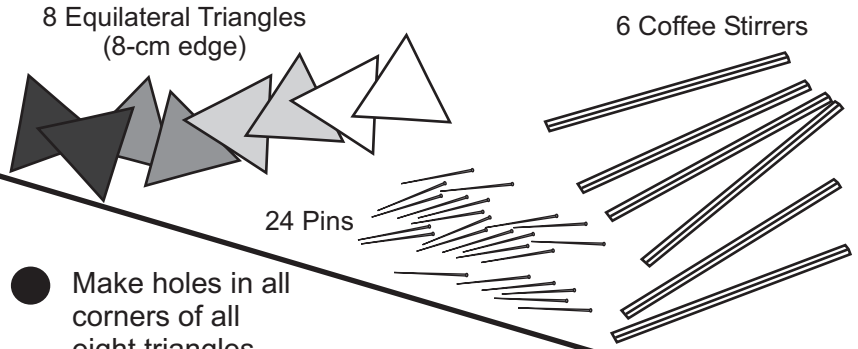
- Open the bottle lid and fill it one-fourth with water.
- Screw on the lid with the plastic straw.



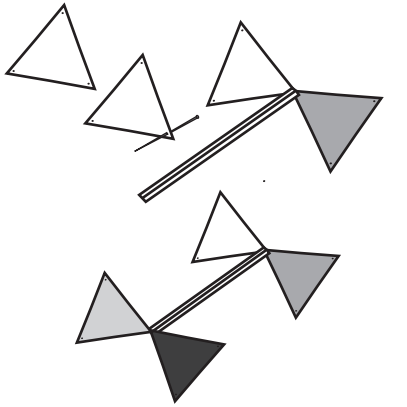
- Quickly invert the bottle and dip the end of the flexible straw in the cup of coloured water.
- As water falls from the lid straw the pressure in the bottle reduces and more water is sucked in from the cup into the bottle.

This Siphon will work until all the coloured water from the cup is drained out.

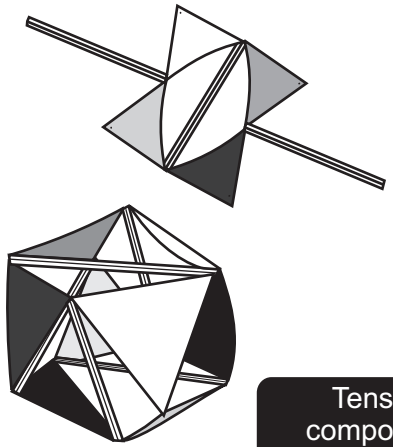
TENSEGRITY WITH TRIANGLES



- Make holes in all corners of all eight triangles.



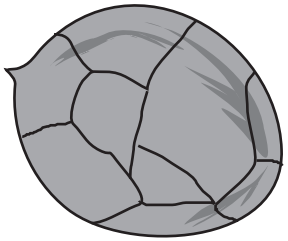
- Fix two triangles with 2 pins on one coffee stirrer (flat straw with 2 tubes).
- Fix two more triangles on the other end of the coffee stirrer.
- Continue assembling. All the 24 pins must go into the 24 holes of the 6 coffee stirrers.
- In the end you will get an elegant structure which will stand on its own.



Tensegrity uses isolated components in compression inside a net of continous tension.

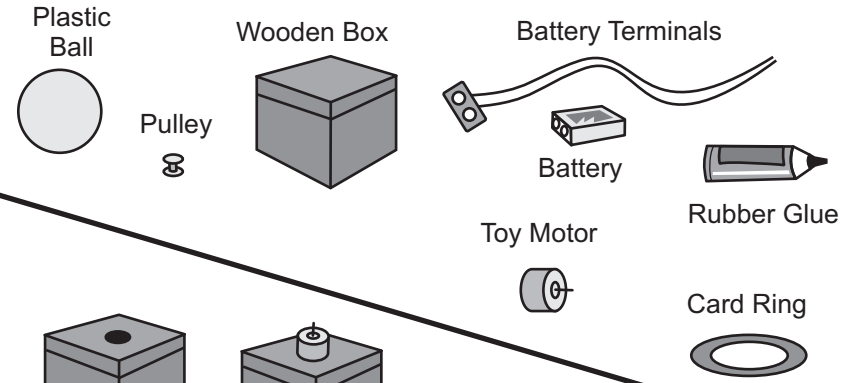
COCONUT PUZZLE

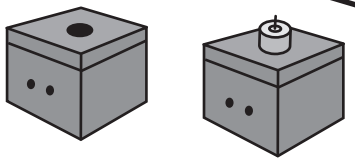
- Next time when you break a coconut keep all its wooden shell pieces.
- Give a child some sticky dough or glue and ask her to assemble the whole coconut shell from its various pieces.
- Assembling the whole coconut shell from its small pieces is a very low cost 3-dimensional jigsaw puzzle!



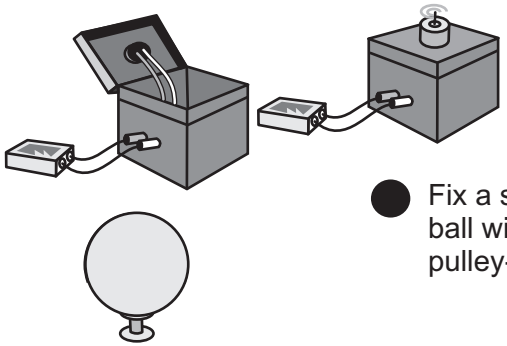
To figure out which piece will fit where in 3-D space is a great intellectual exercise. Archaeologists are all the time collecting pottery pieces and assembling them into pots!

HULA HOOP SATURN

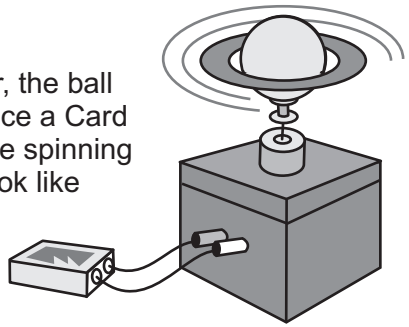




- Fix a toy motor on the top of a wooden box with a lid.

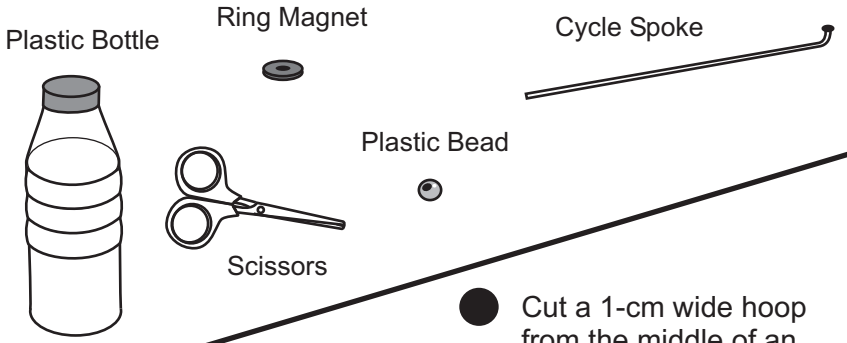


- Connect the motor via terminals to the battery. On connecting it to the battery the motor will spin at a high speed.
- Fix a small plastic pulley to the ball with glue. Then press fit the pulley-ball to the motor shaft.
- On switching "ON" the motor, the ball will spin very fast. Gently place a Card Ring (slightly oversize) on the spinning ball. The spinning ring will look like Saturn's Ring.

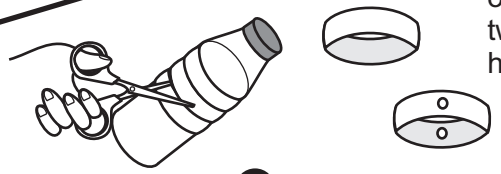


Why does the Ring keep spinning? The spinning ball touches the ring many times and each times it nudges it to continue spinning.

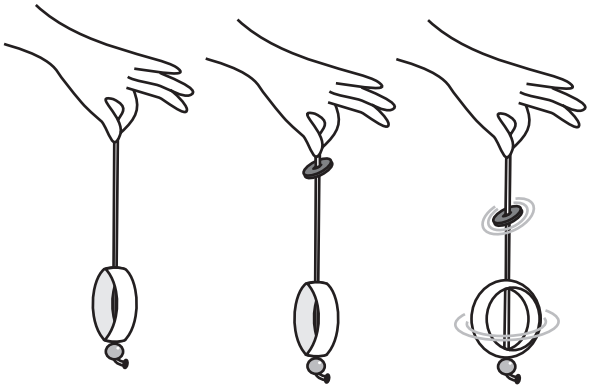
MAGNETIC HOOP SPINNER



- Cut a 1-cm wide hoop from the middle of an old plastic bottle. Make two diametrically opposite holes in the hoop.

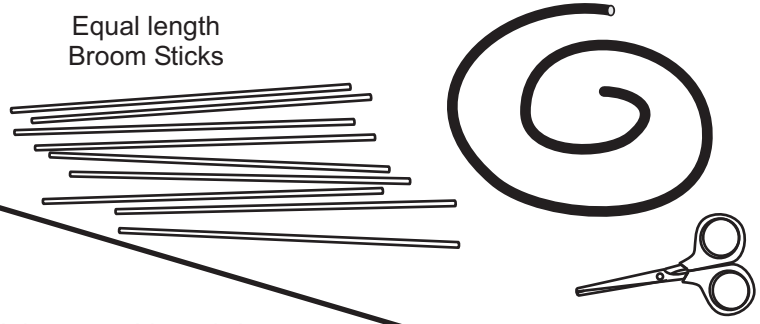


- Place a plastic bead in a cycle spoke to reduce friction. Then place the hoop and finally spin the ring magnet at the top.

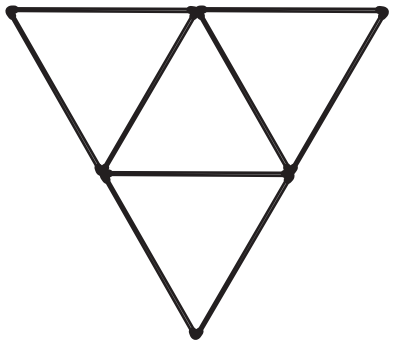


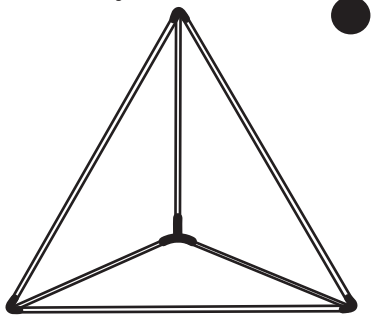
The off-centre movement of the ring magnet will produce vibrations at the lower end. These vibrations will spin the plastic hoop at a fast speed and it will look like a spinning Soap Bubble.

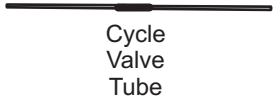
MEANING OF SYNERGY



- Using equal length broom sticks and 2-cm long pieces of cycle valve tube make three equilateral triangles.



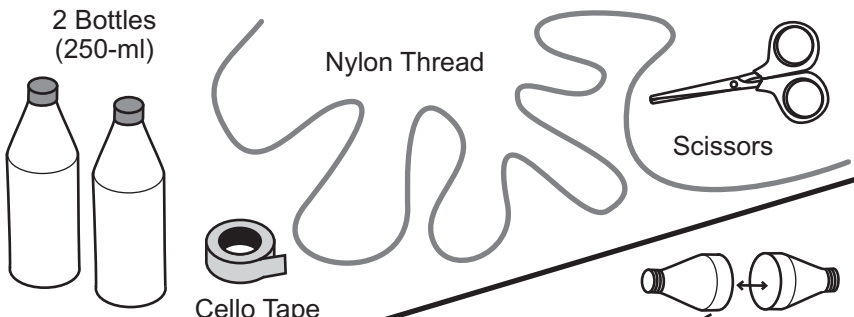


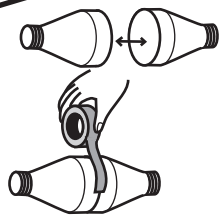


- If you place all 3 triangles in this formation you will actually see 4 similar triangles - with one extra triangle in the middle.
- Three individual triangles can be stacked together like a tepee. Surprisingly, the fourth triangle will automatically emerge in the base.

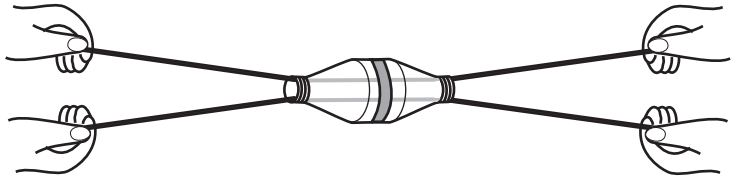
Synergy essentially means that the WHOLE is more than the sum of the PARTS. Here using just THREE triangles we got FOUR. This is synergy!

SHOOTING TWIN BOTTLES

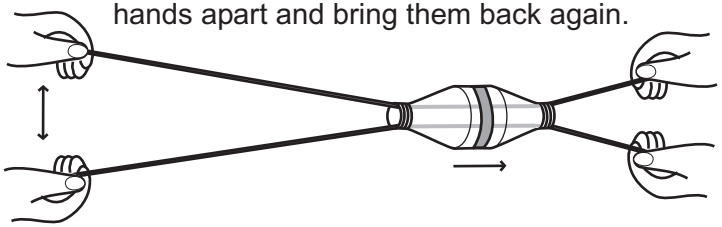




- Cut two bottles 10-cm from the opening. Place the cut bottles back-to-back and tape them to make a double cone.



- Weave two, 2-metre long nylon threads. To shoot the bottles two players hold the thread ends and alternately pull their hands apart and bring them back again.



When a player pulls his hands apart a resultant force vector propels the bottle forwards. Its fun playing with this toy.

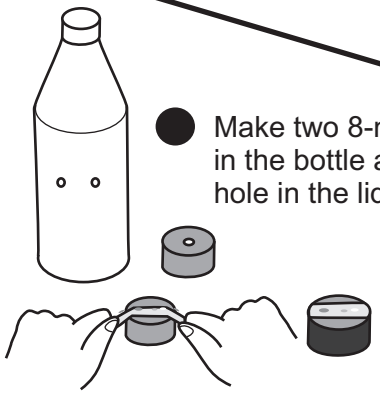
AIR PUMP

Cello Tape

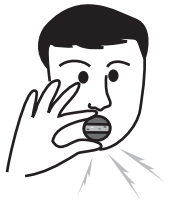
Plastic Bottle

Balloons

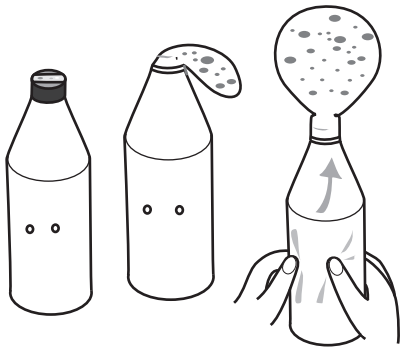
Scissors



- Make two 8-mm holes in the bottle and one hole in the lid.
- Stretch a balloon to cover the hole on the lid. Tape and secure the balloon on the rim of the lid.



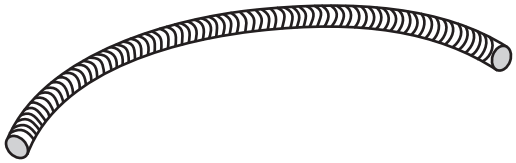
- On blowing through the lid the stretched balloon membrane will vibrate and make a screechy noise.
- Screw the balloon-lid on the bottle. Place a balloon on the lid. Then shut both bottle holes with your thumbs and press the bottle repeatedly This will inflate the balloon.



In this pump the stretched balloon membrane acts like a one-way Delivery Valve. Your thumbs and bottle holes act like the Suction Valve.

SINGING PIPE

Corrugated Plastic Sink Pipe (1-metre)

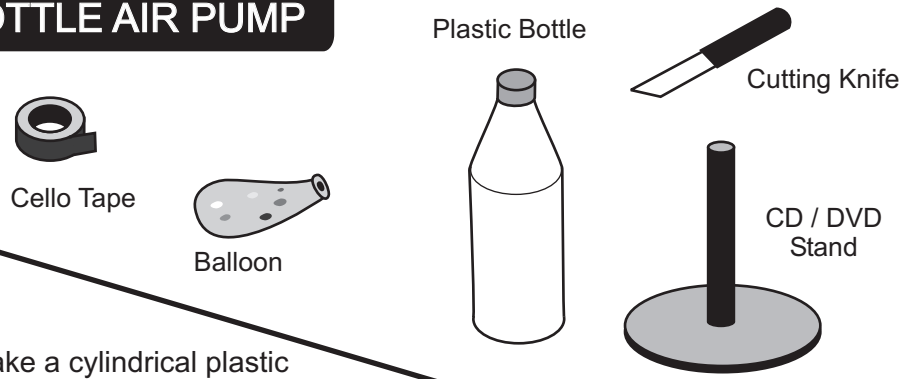


- Kitchen sinks have a corrugated plastic drain pipe. On blowing through one end of this pipe you will hear a musical note.

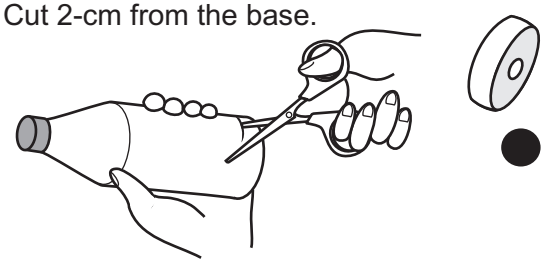
- Hold one end of the pipe and swing it in the air to hear a musical note. By changing the speed of spin you can make different notes.

As air stream flows though the corrugated tube it begins to vibrate and produces musical notes.

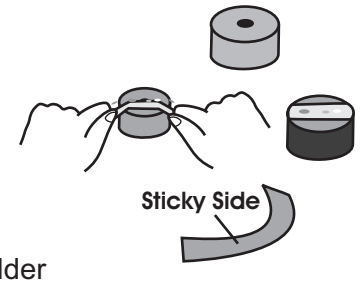
BOTTLE AIR PUMP



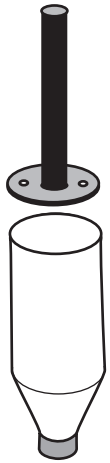
- Take a cylindrical plastic bottle with no corrugations. Cut 2-cm from the base.



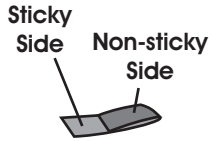
- Make a 1-cm hole in the cut base piece.



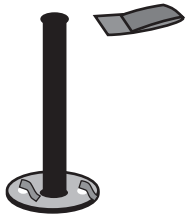
- Make a 8-mm hole in the lid. Stretch a balloon on this hole. Tape balloon to the rim. This will make the Delivery Valve.



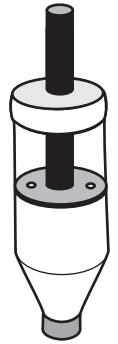
- Cut a CD / DVD holder to fit as a piston inside the bottle. Make two holes in the piston and stick Flap valves.



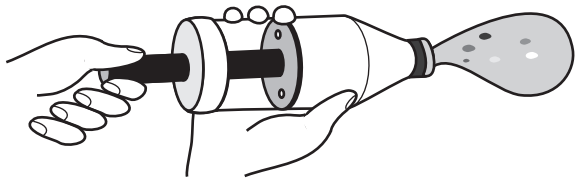
- For making valves - take 3-cm tape. Stick 1-cm on itself. Fix the "sticky" part on the piston. This flap valve will Open / Close.

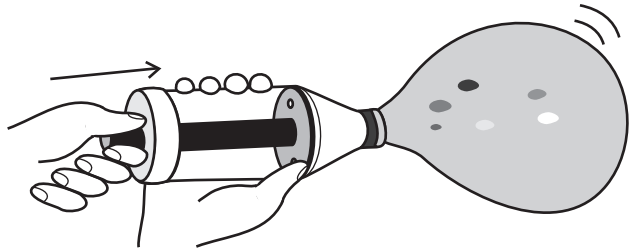


- Assemble the piston in the bottle cylinder. Tape the base to the bottle. Screw the bottle lid with the balloon valve. Now stretch out a balloon on the bottle lid.



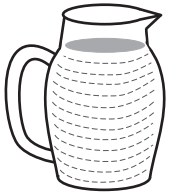
- Move the piston back and forth to inflate the balloon.

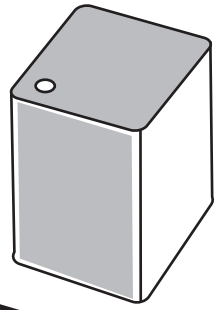


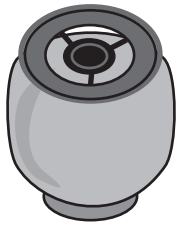


In this pump the plastic bottle is the cylinder, the CD/ DVD holder is the Piston, the lid with a stretched balloon is the Delivery Valve and the two tape Flaps are the Suction Valves. This is a simple and efficient air pump.

TIN SHRINK

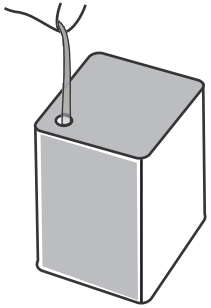

Water Jar


15-Litre Tin


Gas Stove

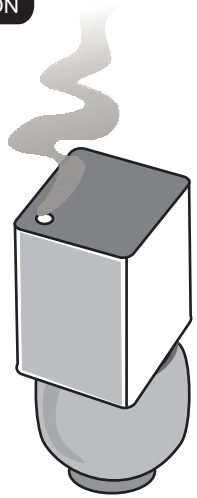
Matchbox

- Pour half a litre water in an empty 15-litre tin can.

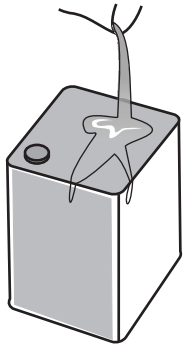


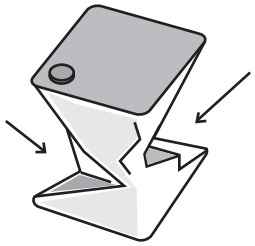
CAUTION: DO THIS EXPERIMENT STRICTLY UNDER ADULT SUPERVISION

- Put the tin on a gas stove and let some of the water boil away as steam.



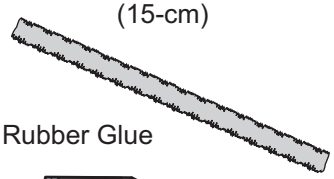
- Then place the tin on the ground and shut its lid. Pour cold water from the top for cooling. Soon the tin will shrink and collapse.

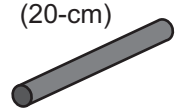




Once the steam escapes the air inside the tin has less pressure. The pressure of the outside air is powerful enough to collapse the tin.

VIBRATING SNAKE


Pipe Cleaner (15-cm)


PVC Pipe (20-cm)

Rubber Glue

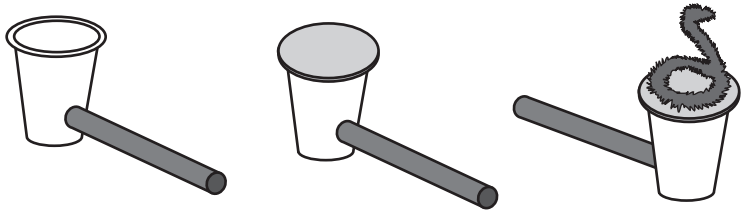
Paper Cup

Scissors

Card Disc

- Make a small hole in a paper cup.

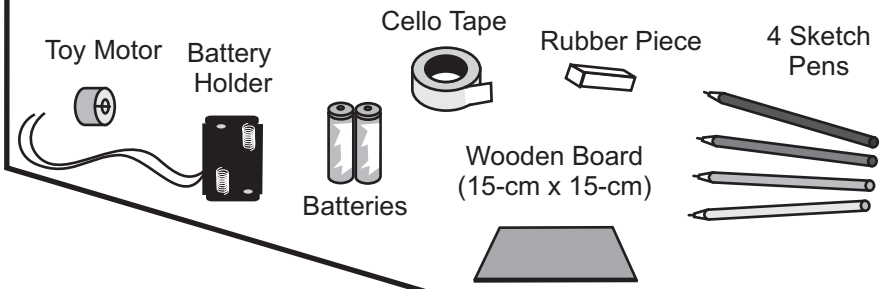
- Press fit the PVC pipe in this hole. Glue a card disc on the cup rim. Place a snake formed from a Pipe Cleaner on the disc.



- As you blow a sound through the tube the Pipe Cleaner snake will start dancing!

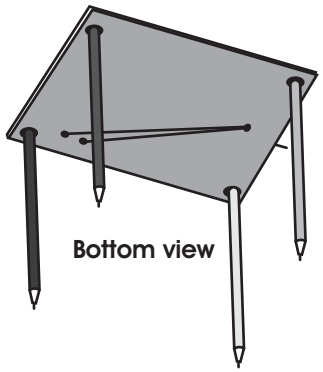
As you blow sound through the pipe the sound waves will produce vibrations in the cup and the fluffy snake will start to dance.

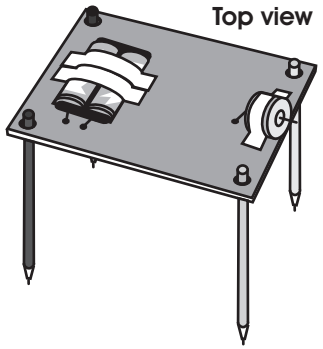
SCRIBBLING ROBOT



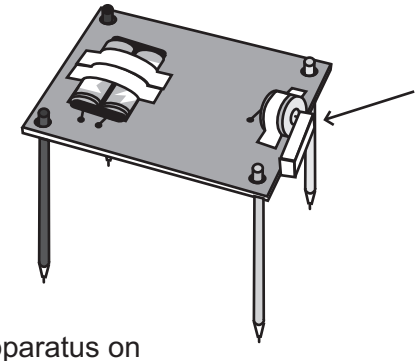
- Make four holes in the corners of the board to fit sketch pens. Make holes to mount motor and batteries.

- Press fit four sketch pens as table legs. Tape the toy motor and the battery pack on the wooden board.

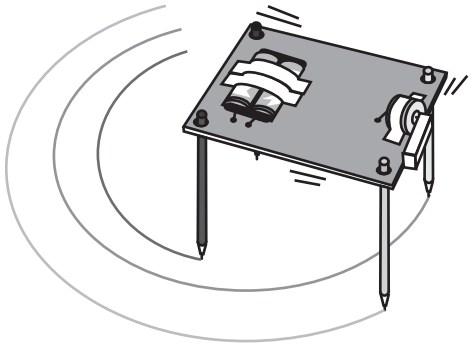




- Fix a 3-cm long rubber piece on the motor shaft. This eccentric will make the whole assembly vibrate.



- Place the whole apparatus on a white sheet with the sketch pen tips resting on the paper. Then start the motor.



The rubber piece eccentric mounted on the motor will make the whole table vibrate. The robot will move and the sketch pens will make circular patterns on paper.